REMARKS

Election

Responsive to the Restriction in the office action mailed May 15, 2007, and as discussed with the Examiner during a telephone conversation on May 3, 2007, Applicant elects Species 1, encompassed by claims 1 and 26. The election is without traverse. The claims readable on the elected species include claims 1, 3-14, and 26. Claims 15-18 and 20 have been withdrawn from consideration.

Objections to the Specification

Applicant has amended paragraph [0055] as suggested by the Examiner to overcome the informality.

Rejections under 35 U.S.C. § 103(a).

The Examiner has rejected claims 1, 3-14, and 26 under 35 U.S.C. § 103(a) of which claims 1 and 26 are the only independent claims. Claims 1, 3, 8, and 26 stand rejected as being unpatentable over Moslehi et al., U.S. Patent No. 6,471,830 (*Moslehi*) in view of Usui, U.S. Patent No. 5,513,765 (*Usui*) and Khater et al., U.S. Patent No. 6,459,066 (*Khater*). Claims 1, 3, 8, and 26 stand rejected as being unpatentable over Tanaka et al., U.S. Patent No. 6,210,539 (*Tanaka*) in view of *Usui* and *Khater*. Claim 4 stands rejected as being unpatentable over *Tanaka* and *Usui* in view of *Khater* and Roderick, U.S. Patent No. 6,353,206 (*Roderick*). Claim 5, 9, and 10 stand rejected as being unpatentable over *Usui,* in view of *Tanaka* and *Khater* and further in view of *Moslehi*. Claim 6 stands rejected as being unpatentable over *Tanaka* in view of *Usui* and *Khater* in further view of *Moslehi* and Denda et al., U.S. Patent No. 6,440,260 (*Denda*). Claim 7 stands rejected as being unpatentable over *Tanaka* in view of *Usui* and *Khater* in further view of Dible et al., U.S. Patent No. 6,042,686 (*Dible*). Claim 11 stands rejected as being unpatentable over *Tanaka* in view of *Usui* and *Khater* and in further view of *Denda* and Liu et al., U.S. Patent Application Publication No. 2002/0027205 (*Liu*). Claims 12 stands

rejected as being unpatentable over *Tanaka* in view of *Usui* and *Khater* and in further view of *Denda* and Pu et al., U.S. Patent No. 6,825,618 (*Pu*). Claim 13 stands rejected as being unpatentable over *Tanaka* in view of *Usui* and *Khater* and in further view of *Denda* and Hanawa, U.S. Patent No. 6,027,601 (*Hanawa*). Claim 14 stands rejected as being unpatentable over *Tanaka* in view *Usui* and *Khater* and in further view of *Denda*, *Hanawa*, and *Moslehi*.

The Examiner, in this and previous Office Actions, has combined references without taking into consideration the additional inventive steps necessary to get the combined references to produce or maintain uniform plasmas. Introducing the electrical series connection from *Usui* into *Tanaka*, with no other teachings of design modifications would disrupt the uniform plasma generated by the precise placement of the coils in *Tanaka* and render *Tanaka* inoperable for its intended purpose. Similarly, the series connection that is operable in *Usui*, having a stationary external coil, would generate additional design considerations when combined with *Moslehi*, which has internal coils that can be positioned relative to the substrate. Additionally *Usui* is directed at an etch process where *Moslehi* is directed toward solving the problem of deposition in high aspect ratio features on a substrate. The combined references do not teach or suggest how to overcome any of the new design considerations arising from the combination.

This reasoning extends to the further reliance on additional secondary references such as *Khater*. For example, *Tanaka's* essential characteristic is its control of electric fields in a chamber (see FIG. 5) and around a coil. But an essential characteristic of a Faraday shield, such as the shield disclosed in *Khater*, is that it blocks coupling of electric fields from a coil. Therefore, any combination of *Tanaka* and *Khater* is destructive to the field in *Tanaka* and would be counter-motivated.

The following supporting remarks are respectfully submitted.

Rejections based on *Tanaka* in view of *Usui* and *Khater*

The Examiner's position with regard to claims 1 and 26 is that *Tanaka* teaches all of the elements of claims 1 and 26 but does not teach that "the circuit is a series circuit and also

includes substrate support that is biased by RF source and the peripheral ionization source is connected to substrate support." The Examiner acknowledges that Tanaka et al. also "do not teach a slotted faraday shield between the induction element and plasma." The Examiner further states that *Usui* teaches a series RF circuit that includes a substrate support electrode and an inductive plasma coil connected in series with a matching circuit such that both capacitive and inductive plasma are generated within a vacuum chamber. The Examiner concludes that one of ordinary skill in the art at the time of the invention would use an RF series circuit that also include the substrate support which is biased by the RF source as taught by *Usui* in the apparatus of *Tanaka* to generate both inductive and capacitive plasma and thus obtain uniform and high density plasma across the wafer surface. Applicant disagrees with the Examiner for the following reasons.

First, there would be no motivation to combine *Usui* with *Tanaka* as *Tanaka* fulfills its objective as an improvement over art such as *Usui* by producing a highly uniform plasma in a low pressure environment as evidenced by the paragraph at col. 6, lines 44-48 reproduced below:

> In view of the high degree of uniformity which can be imparted to a plasma field in accordance with the present invention, the possibility of successfully processing large diameter substrates, up to 300 mm in diameter, particularly for deposition of metal coatings is presented.

Usui teaches an inductive plasma coil on the outside of the chamber as evidenced by FIGS. 1, 2, 3, and 5 in *Usui*. *Tanaka* states at col. 2 lines 6-15:

> A number of designs and arrangements for plasma generating coils have been proposed which are intended to improve the uniformity of the generated plasma. Typically, one or more coils are disposed at locations above the wafer surface and according to many of these proposals, the coils are located outside of the chamber in which the plasma itself is configured. Investigations have indicated that these prior coil arrangements tend to produce plasma fields which have substantial plasma density non-uniformity across the wafer surface.

Based on FIGS. 1, 2, 3 and 5 in *Usui*, the plasma generating apparatus in *Usui* is the type described by *Tanaka* above and to that end, one skilled in the art would not combine the references to add the series connection from the older art (*Usui*) with *Tanaka* which already

produces a highly uniform plasma as stated above. Additionally, one skilled in the art would recognize that at the time of the priority date (December 8, 1993), industry was dealing with smaller wafer sizes, 200mm as opposed to 300mm. Increased inductance is required for the larger coils which in turn increases the voltage at the coils as well. The increase in coil size introduces many new technical problems to be solved for a workable implementation of what would appear to be an "obvious" coil design modification.

Second, assuming *arguendo* that *Tanaka* was modified by *Usui*, haphazard or random addition of a capacitive element to the plasma, which would be introduced by biasing the substrate support through a series RF connection between the generator, coil and support, would introduce a series of technical problems, not contemplated by the Examiner, to solve in order to bring such a solution into practice. For example, *Tanaka*, in relation to FIG. 5, discloses that the coils are to be placed in precise locations with respect to the substrate in order to generate the uniform equipotential lines of the plasma illustrated in FIG. 5. Introducing the capacitive element through the series connection with the substrate would disrupt the plasma arrangement without other adjustments to the system that are not disclosed in either reference.

Additionally one skilled in the art would recognize that the apparatus in *Usui* would have difficulties producing plasmas at higher frequencies (in excess of 1 to 2 MHz), which are typical frequencies for effective ICP plasma generation for wafer sizes at 300mm. The lower operating frequencies would increase the skin depth and combined with the low pressure conditions will introduce significant interference between the coil and other metallic hardware within the chamber. The plasma-coupling will become non-efficient. One of ordinary skill would recognize that even though components of *Usui* could be combined with *Tanaka* (a "mechanical" connection), the simple connection ignores the shortcomings of *Usui* for a 300mm wafer as well as any process conditions, such as gas pressure, industrial frequency range in use, additional hardware in the plasma chamber, etc. It is not obvious from the simple "mechanical" connections of the components as to how to combine high density plasma generation hardware with a biased substrate to control the directionality of the process.

The Examiner relies on *Khater* to supply the missing slotted faraday shield between the induction element and plasma. But adding the Faraday shield of *Khater* to *Tanaka* would eliminate electric field coupling between Tanaka's coil 60 (see FIG. 5) and the plasma, which would make the whole point of Tanaka's adjustable coil useless in achieving Tanaka's primary goal of shaping the field by adjusting coil height. *Khater* may disclose a Faraday shield, but *Khater* does not disclose using the Faraday shield in conjunction with an RF series circuit that connects the coil, the substrate support, and an RF source. In Applicant's series circuit, the support capacitively couples to the plasma at the center while the coil, which is shielded from capacitive coupling, inductively couples to the plasma at the periphery. No cited combination teaches how to achieve this.

Applicant therefore respectfully requests that the rejections for independent claims 1 and 26 be withdrawn. Further, claims 3 and 8 depend from claim 1 and are also allowable for the same or similar reasons set forth above. Applicant respectfully requests that these rejections also be withdrawn.

In addition, in rejecting dependent claims 5 and 9, the Examiner applies *Moslehi* as teaching capacitively coupling a coil to a substrate support. This is inconsistent with the Examiner's correct characterization of *Moslehi* on page 5 of the Office Action as not teaching a series circuit that includes the peripheral ionization source and the substrate support.

Moreover, claims 4-7 and 9-14 depend from independent claim 1 and their rejections also stem from the combination of *Tanaka* and *Usui*. None of the additional references cited for these dependent claims teach or disclose "the circuit is a series circuit and also includes substrate support that is biased by RF source and the peripheral ionization source is connected to substrate support." Therefore, based on the reasoning set forth above, these claims are also allowable and Applicant respectfully requests that these rejections be withdrawn.

Rejections based on *Moslehi* in view of *Usui* and *Khater*

The Examiner's position with regard to claims 1 and 26 is that *Moslehi* teaches all of the elements of claims 1 and 26 but does not teach that "the circuit is a series circuit and also

includes substrate support that is biased by RF source and the peripheral ionization source is connected to substrate support." Further, Moslehi et al. also "do not teach a slotted faraday shield between the induction element and plasma." The Examiner further states that *Usui* teaches a series RF circuit that includes a substrate support electrode and an inductive plasma coil connected in series with a matching circuit such that both capacitive and inductive plasma are generated within a vacuum chamber. The Examiner concludes that one of ordinary skill in the art at the time of the invention would use an RF series circuit that also include the substrate support which is biased by the RF source as taught by *Usui* in the apparatus of *Moslehi* to generate both inductive and capacitive plasma and thus obtain uniform and high density plasma across the wafer surface. Applicant disagrees with the Examiner for similar reasons set forth above as well the following reasons below.

First of all, text of *Moslehi* referenced by the Examiner (col. 9, line 55 through col. 10, line 65) describes a system that requires separate control of the power to the coil and to the substrate support. This is achieved with power circuits to the substrate support and coil that are independent. This would not be the case if the substrate support were connected in series with the peripheral ionization source, as *Usui* does with the external coil.

Moslehi is directed toward solving several problems in the art, most importantly better coverage of high aspect ratio features by a sputtering deposition process. Additional needs considered by *Moslehi* include "a need for an ICP PVD collimation technique that provides the capability for real time adjustment of ICP PVD antenna position relative to the target and substrate," "an improved ICP PVD collimation technology that does not consume the ICP PVD antenna and therefore does not require the ICP PVD antenna to be made of the same material as the target," and "an ICP PVD technology with the capability of using a multi-zone ICP PVD antenna to allow for real-time independent control of the ionization and collimation in distinct areas of the process environment." (col. 3, lines 46-57) The coil (antenna) in *Usui* is not designed to change its position relative to the substrate. The coil in *Usui* is positioned outside of the chamber and thus would not come into contact with the plasma, thus mooting any issues with the composition of the coil. Additionally, *Usui* is directed toward an etching process in a high

vacuum condition. One of ordinary skill in the art would understand that the challenges of producing a plasma for an etching process are different from those for a deposition process, especially for achieving a better deposition on high aspect ratio features.

Also, similar to the discussion regarding *Tanaka* above, haphazard or random addition of a capacitive element to the plasma, which would be introduced by biasing the substrate support through a series RF connection between the generator, coil and support from an apparatus with a stationary external coil to an apparatus with a movable internal coil and movable chuck, would introduce a new series of technical problems, not contemplated by the Examiner, to solve in order to bring such a solution into practice. For example, one skilled in the art would recognize that the resulting combination would introduce stray capacitances between the windings, or between the electrode and the windings that would need to be addressed. This is a factor that must be taken into account in order to set up the series or parallel resonance parameters correctly, which isn't necessarily obvious from just the simple electrical connection of the components. The apparatus recited in claims 1 and 26 accounts for the stray capacitance as part of the design and by embedding the inductive elements into the electrode, stray capacitances can be eliminated, or at least used in a way to set proper resonance properties, which are not disclosed in the combination of *Moslehi* and *Usui*.

As stated above, *Khater* may disclose a Faraday shield, but *Khater* adds nothing to *Moslehi*: *Khater* does not disclose using the Faraday shield in conjunction with an RF series circuit that connects the coil, the substrate support, and an RF source.

Applicant therefore respectfully requests that the rejections for independent claims 1 and 26 be withdrawn. Further, claims 3 and 8 depend from claim 1 and are also allowable for the same or similar reasons set forth above. Applicant respectfully requests that these rejections also be withdrawn.

Conclusion

Applicant has made a bona fide effort to respond to each and every requirement set forth in the Office Action. In view of the foregoing remarks given herein, Applicant

respectfully believes this case is in condition for allowance and respectfully requests allowance of the pending claims. If the Examiner believes any detailed language of the claims requires further discussion, the Examiner is respectfully asked to telephone the undersigned attorney so that the matter may be promptly resolved. The Examiner's prompt attention to this matter is appreciated.

Applicant is of the opinion that no additional fee is due as a result of this Amendment except for a one month extension of time. If any additional charges or credits are necessary to complete this communication, please apply them to Deposit Account No. 23-3000.

Respectfully submitted,

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